

## WHAT IS CLAIMED:

1. A trefoil heat exchanger for use within a rotary kiln that includes a cylindrical steel shell with an internal refractory lining, said trefoil comprising:
  - 5 at least three spoke-like refractory legs, each one of the legs extending substantially radially outwardly from a center of the trefoil and including a foot, a mating end opposing the foot, and a body extending between the foot and the mating end, each one of the feet adjoining the kiln shell, each one of the mating ends adjoining adjacent ones of the mating ends substantially at a center of the
  - 10 trefoil, each one of the legs preformed outside of the kiln for installation as a single-leg unit such that the body of each one of the legs is continuous between the foot and the mating surface.
2. The trefoil of claim 1 wherein each one of the legs supports other ones of the legs
- 15 as the kiln rotates.
3. The trefoil of claim 2 wherein each one of the legs has an overall length approximately equal to an internal radius of the kiln shell.
- 20 4. The trefoil of claim 2 wherein each one of the legs has an overall length approximately equal to an internal radius of the kiln shell minus a positioning steel member allowance proximate the kiln shell and minus a mating allowance proximate a center of the trefoil.
- 25 5. The trefoil of claim 2 wherein the foot of each one of the legs is secured to the kiln shell and is substantially uniformly circumferentially spaced apart from other ones of the feet.
6. The trefoil of claim 2 further comprising a steel channel-like member coupled to
- 30 the kiln shell for receiving the foot therein.

7. The trefoil of claim 6 wherein the trefoil further comprises shims disposed between the foot of at least one leg and the kiln shell to enable alignment of the trefoil relative to the kiln shell.
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8. The trefoil of claim 2 wherein the at least three legs consist of exactly three legs that are spaced approximately 120 degrees apart.
9. The trefoil of claim 2 wherein each one of the mating ends includes a pair of  
10 opposing mating surfaces, each one of the mating surfaces of each one of the mating ends being even such that each one of the mating surfaces lack interlocking protrusions and recesses.
10. The trefoil of claim 2 wherein each one of the mating ends forms a wedge, each  
15 one of the wedges urging against adjacent ones of the wedges proximate a kiln center.
11. The trefoil of claim 10 wherein each the wedges form a pie-shaped hub.
12. The trefoil of claim 10 wherein each one of the wedges forms an oblique first  
20 surface and an oblique second surface opposing the first surface, the first surface urging against a matching wedge surface of an adjacent leg, the second surface urging against a matching wedge surface of an opposing adjacent leg.
13. The trefoil of claim 10 wherein the at least three legs consist of three legs that are  
25 circumferentially spaced approximately 120 degrees apart, each one of the wedges forming an included angle of approximately 120 degrees.
14. The trefoil of claim 10 wherein the trefoil further comprises a layer of grout disposed between adjacent wedges.

15. The trefoil of claim 10 wherein each one of the wedges contacts adjacent ones of the wedges.
16. The trefoil of claim 10 wherein each one of the legs is symmetrical about a longitudinal centerline.
17. The trefoil of claim 2 wherein the center of the trefoil is substantially aligned with a longitudinal center of the rotary kiln.
18. A trefoil for use within a rotary kiln that includes a cylindrical steel shell with an internal refractory lining, said trefoil consisting of plural elongate, one-piece legs formed of a material comprising a refractory, the legs oriented substantially radially and continuously extending from a center of the trefoil to a periphery of the trefoil adjoining the kiln shell.
19. The trefoil of claim 18 wherein each one of the legs includes a foot adjoining the kiln shell and a mating surface adjoining mating surfaces of adjacent ones of the legs substantially at a center of the trefoil.
20. The trefoil of claim 19 wherein each one of the mating surfaces form a wedge, each one of the wedges including an oblique first surface and an oblique second surface opposite the first surface, the first surface urging against a matching surface of an adjacent leg, the second surface urging against a matching surface of an opposing adjacent leg.
21. The trefoil of claim 19 wherein each one of the mating surfaces contacts mating surfaces of adjacent ones of the legs.
22. The trefoil of claim 18 further comprising a steel channel-like member coupled to the kiln shell for receiving the foot therein.

23. The trefoil of claim 18 wherein each one of the legs has an overall length approximately equal to an internal radius of the rotary kiln.
24. A method of installing a refractory trefoil in a rotary kiln comprising the steps of:
- 5 a) preforming at least three legs outside of the rotary kiln of a material comprising a refractory;
- b) radially positioning a first one the legs at an interior first surface of a rotary kiln;
- 10 c) radially positioning a second one of the legs at an interior second surface of the rotary kiln that is circumferentially spaced apart from the first surface such that an inner end of the second leg adjoins an inner end of the first leg;
- 15 d) radially positioning a third one of the legs at an interior third surface of the rotary kiln that is circumferentially spaced apart from the second surface such that an inner end of the third leg adjoins the inner end of each one of the first leg and the second leg, whereby each one of the at least three legs supports at least a portion of the trefoil during rotation of the rotary kiln.
25. The method of claim 24 further comprising the step of pre-curing the at least three legs prior to step b, step c, and step d.
- 20 26. The method of claim 24 further comprising the step of installing a channel-like member on each one of the kiln first surface, the kiln second surface, and the kiln third surface, each one of the radially positioning steps b, c, and d including inserting a foot of the trefoil leg into the channel-like member.
- 25 27. The method of claim 24 further comprising the step of installing shims between the kiln shell and at least one of the legs to adjust the position of the legs and to position each one of the channel like members.